

1     CLAIMS

2             Having thus described our invention, what we claim as new and desire to secure  
3     by Letters Patent is as follows:

- 4     1. A method comprising diagnosing from a repository at least one fault in a system, said  
5     repository represented as a directed graph having one or more undivided directed  
6     subgraphs, the step of diagnosing comprising the steps of:  
7             receiving a first description of said at least one fault;  
8             employing said first description to identify a response from the said repository;  
9             if the response is a diagnosis stopping, otherwise identifying at least one  
10     subgraph responsive to said first description;  
11             using said at least one subgraph in determining said diagnosis, stopping if said  
12     diagnosis results, otherwise forming a modified description based upon said at  
13     least one subgraph; and  
14             replacing said first description with said modified description and repeating  
15     the steps of receiving, employing, identifying and using until said diagnosis  
16     results.
- 17     2. A method as recited in claim 1, wherein the first description is completely covered by  
18     the diagnosis, the method further comprising implementing a solution based on the  
19     diagnosis.
- 20     3. A method as recited in claim 1, wherein the first description includes a set of  
21     symptoms describing said at least one fault.
- 22     4. A method as recited in claim 3, wherein the modified description includes an  
23     additional set of symptoms identified for probing by the subgraph.
- 24     5. A method as recited in claim 1, wherein the first subgraph is identified by a method

1 employing an index mapping descriptions to initial subgraphs, the trivial index simply  
2 mapping all descriptions to one subgraph.

3 6. A method as recited in claim 1, wherein said repository is remote and said undivided  
4 subgraphs are downloaded from said repository to a local agent performing the diagnosis  
5 as needed.

6 7. A method as recited in claim 1, wherein said system is a system taken from a group of  
7 systems consisting of: a machine; a software program; a process; and any combination of  
8 these.

9 8. A method as recited in claim 1, having a limitation taken from a group of limitations  
10 consisting of:

11 wherein each said undivided subgraph is implemented as executable code;

12 wherein said executable code is written in an object-oriented programming language;

13 wherein said executable code is written in a programming language that supports late  
14 binding;

15 wherein said programming language supports late binding and on-demand downloading  
16 of classes;

17 wherein said programming language that is object-oriented and supports late binding and  
18 on-demand downloading of classes is Java;

19 wherein said local agent is a machine;

20 wherein said remote repository is downloaded as needed onto a small computing device;

1 wherein said remote repository is hosted by a service provider supporting a plurality of  
2 customers and having each customer download subgraphs as needed to perform  
3 diagnosis;

4 wherein at least one of said customers is a customer support center diagnosing faulty  
5 systems on behalf of a plurality of its own customers;

6 wherein said customer is a field representative performing diagnosis of a failing system;

7 wherein said customer is a faulty system operating in a self-diagnostic mode; and

8 wherein said faulty system applies the solution identified by the fault diagnosis system in  
9 an autonomic, self-healing mode; and

10 any combination of these limitations.

11 9. A method as recited in claim 1, wherein said diagnosing is done proactively to prevent  
12 faults from occurring in the future and/or to train someone to use said system successfully  
13 so that faults will not occur.

14 10. A method as recited in claim 1, wherein said repository enables an on-demand fault  
15 diagnosis system with a service provider charging each customer for an amount of  
16 resources consumed during any diagnosis session.

17 11. An article of manufacture comprising a computer usable medium having computer  
18 readable program code means embodied therein for causing diagnosis from a repository  
19 of at least one fault in a system, the computer readable program code means in said article  
20 of manufacture comprising computer readable program code means for causing a  
21 computer to effect the steps of claim 1.

1 12. A program storage device readable by machine, tangibly embodying a program of  
2 instructions executable by the machine to perform method steps for diagnosing from a  
3 repository at least one fault in a system, said method steps comprising the steps of claim  
4 1.

~

5 13. An apparatus comprising means for diagnosing from a repository at least one fault in  
6 a system, said repository represented as a directed graph having of one or more undivided  
7 directed subgraphs, the means for diagnosing comprising:

8 means for receiving a first description of said at least one fault;

9 means for employing said first description to identify a response from the said  
10 repository;

11 means for if the response is a diagnosis stopping, otherwise identifying at least  
12 one subgraph responsive to said first description;

13 means for using said at least one subgraph in determining said diagnosis,  
14 stopping if said diagnosis results, otherwise forming a modified description based  
15 upon said at least one subgraph; and

16 means for replacing said first description with said modified description and  
17 repeating the steps of receiving, employing, identifying and using until said  
18 diagnosis results.

19 14. A computer program product comprising a computer usable medium having  
20 computer readable program code means embodied therein for causing diagnosis from a  
21 repository of at least one fault in a system, the computer readable program code means in  
22 said computer program product comprising computer readable program code means for  
23 causing a computer to effect the functions of claim 13.

24 15. A method for diagnosing a fault, said method comprising:

25 commencing a diagnosis session;

1 initializing a current state, the current state being symptoms comprising an initial  
2 description of a fault being diagnosed;

3 identifying one graph from a repository of graphs which, when taken together, encode  
4 symptoms and diagnoses of a system, and assigning said one graph to be the current  
5 graph;

6 retrieving said current graph from the repository;

7 assigning one node of the current graph to be the current node;

8 identifying the node type of the current node; and

9 if the current node is of type diagnosis, then returning the diagnosis associated  
10 with the node as the diagnosis of the fault;

11 if the node type is not of type diagnosis then performing a particular node type  
12 operation, and repeating the step of identifying the node type of the current node,  
13 until the node type of the current node is of type diagnosis.

14 16. A method as recited in claim 15, wherein the step of identifying one root graph  
15 comprises employing indexing graphs by symptoms.

16 17. A method as recited in claim 15, wherein:

17 the repository of directed graphs is a remote repository, remote from a process running  
18 the fault diagnosis session, said remote repository comprising a complete set of directed  
19 graphs which taken together encode the symptoms and diagnoses of the fault diagnosis  
20 system;

1 the step of identifying one graph incorporates logic to remotely ask the repository to  
2 identify one graph at a known or discoverable location; and

3 the step of retrieving incorporates logic to retrieve remotely from said known or  
4 discoverable location.

5 18. An article of manufacture comprising a computer usable medium having computer  
6 readable program code means embodied therein for causing diagnosis of a fault the  
7 computer readable program code means in said article of manufacture comprising  
8 computer readable program code means for causing a computer to effect the steps of  
9 claim 15.

10 19. A program storage device readable by machine, tangibly embodying a program of  
11 instructions executable by the machine to perform method steps for diagnosing a fault,  
12 said method steps comprising the steps of claim 15.

13 20. A method as recited in claim 15, wherein said repository enables an on-demand fault  
14 diagnosis system with a service provider charging each customer for an amount of  
15 resources consumed during any diagnosis session.

16 21. A method as recited in claim 15, wherein:

17 if the current node is of type call-graph, then the step of performing a particular node type  
18 operation includes setting the current graph to be a graph associated with the call-graph  
19 node, and repeating the steps of retrieving and assigning;

20 if the current node is of type functional-branch, then the step of performing a particular  
21 node type operation includes evaluating a function associated with the functional-branch  
22 node over the current state of the diagnosis session, and assigning the value of the

1 function to be the current node;

2 if the current node is of type question, then the step of performing a particular node type  
3 operation includes asking a question associated with the current node, collecting an  
4 answer to the question, updating the current state with a pair having a form <question,  
5 answer>, traversing an edge labeled by the answer or by a function that accepts the value  
6 as being valid, reaching a new node in the current graph, and assigning the new node to  
7 be the current node;

8 if the current node type is of type test, then the step of performing a particular node type  
9 operation includes performing a test on the faulty system, adding additional symptoms to  
10 the current state based on the test results, traversing the edge leaving the current node to  
11 reach a new node and assigning the new node to be the current node;

12 if the current node type is of type lookup, then the step of performing a particular node  
13 type operation includes querying a source external to the diagnosis system and the user,  
14 adding additional symptoms to the current state based on the query results, traversing the  
15 edge leaving the current node to reach a new node and assigning the new node to be the  
16 current node; and

17 if the current node type is of type state-transformation, then the step of performing a  
18 particular node type operation includes applying a function associated with the  
19 state-transformation node to the current state to modify the current state, traversing the  
20 edge leaving the current node to reach a new node and assigning the new node to be the  
21 current node.

22 22. A method as recited in claim 15, wherein:

23 a node of type diagnosis is a node representing one definitive diagnosis of the  
24 fault and optionally supplying an action plan to remedy the fault;

1 a node of type call-graph is a node connecting one graph to another graph,  
2 allowing composition of graphs;

3 a node of type functional-branch is a node which allows a transfer of control  
4 to any other node in the current graph where the new node is the computed  
5 value of a function (associated with the functional-branch node) of the current  
6 state of the diagnosis session, where the current state is represented by the set  
7 of all <question, answer> pairs formed from questions already answered in the  
8 current session; and

9 a node of state-transformation is a node which allows modification of the  
10 current state by applying a function associated with the state-transformation  
11 node to the current state to modify it.